

Chapter 1

Introduction

The United States Budget Reconciliation Act of 1993 mandates reallocation of a minimum of 200 MHz of spectrum below 5 GHz for licensing to nonfederal users. One of the objectives is to promote and encourage novel spectrum-inspired technology developments and wireless applications. Many user organizations and communications companies have been developing advanced modulation techniques in order to more efficiently use the spectrum.

In 1998, the international Space Frequency Coordination Group (SFCG) adopted a spectral mask that precludes the use of a number of classical modulation schemes for missions launched after 2002. The SFCG has recommended several advanced modulations that potentially could reduce spectrum congestion. No one technique solves every intended application. Many trade-offs must be made in selecting a particular technique, the trade-offs being defined by the communications environment, data integrity requirements, data latency requirements, user access, traffic loading, and other constraints. These new modulation techniques have been known in theory for many years, but have become feasible only because of recent advances in digital signal processing and microprocessor technologies.

This monograph focuses on the most recent advances in spectrum-efficient modulation techniques considered for government and commercial applications. Starting with basic, well-known digital modulations, the discussion will evolve to more sophisticated techniques that take on the form of constant envelope modulations, quasi-constant envelope modulations, nonconstant envelope modulations, and finally Nyquist-rate modulations. Included in the discussion will be a unified treatment based on recently developed cross-correlated trellis-coded quadrature modulation (XTCQM), which captures a number of state-of-the-art spectrally efficient modulation schemes. Performance analysis, computer simulation results, and their hardware implications will be addressed. Comparisons of

different modulation schemes recommended by the Consultative Committee for Space Data Systems (CCSDS), an international organization for cross support among space agencies, for SFCG will be discussed.